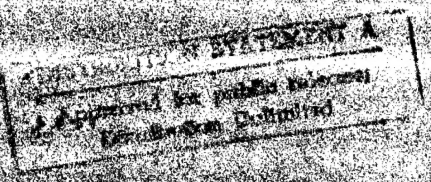
# WATER QUALITY

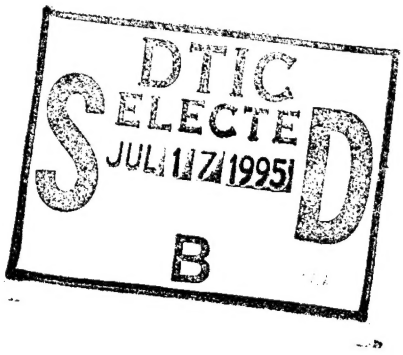
## Information on Salinity Control Projects in the Colorado River Basin

GAO

**United States**
**General Accounting Office**
**Washington, D.C. 20548**

**Resources, Community, and**
**Economic Development Division**

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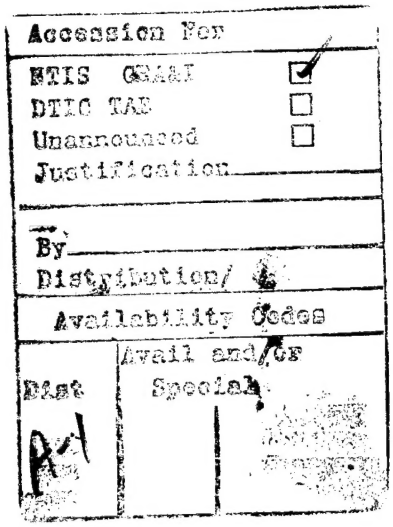
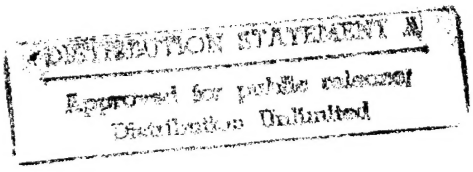
March 29, 1995




The Honorable George Miller
Ranking Minority Member
Committee on Resources
House of Representatives

The Honorable Richard J. Durbin
Ranking Minority Member
Subcommittee on Agriculture,
Rural Development, Food and
Drug Administration
Committee on Appropriations
House of Representatives

The Colorado River provides municipal and industrial water for more than 18 million people in seven states; it also provides irrigation water for about 2 million acres of land. Yet the salinity, or salt content, of the river is high, in large part because of natural features such as underlying salt formations and saline springs. Agriculture is also a large contributor of salt to the river, as irrigation water seeps through saline soils and returns to the river. Salinity in the Colorado River corrodes water pipes and damages crops, at an annual cost of about $1 billion, according to projections by the Department of the Interior's Bureau of Reclamation (BOR). To address such problems, the Congress passed the Colorado River Basin Salinity Control Act of 1974. Title II of the act authorized the Secretary to construct several salinity control projects, most of which are located in Colorado, Utah, and Wyoming. Amendments to the act in 1984 authorized additional projects for BOR and authorized projects by the Department of the Interior's Bureau of Land Management (BLM) and by the Department of Agriculture (USDA). In addition, under the Clean Water Act, the Environmental Protection Agency (EPA) approved standards established by the states for salinity levels for the river water.




Concerned about whether the various title II projects are effectively combating salinity, you asked us for information on (1) the projects' cost and status, (2) factors considered in selecting salinity control methods, and (3) the Department of the Interior's measures of the salinity control program's effectiveness. You also requested information on the responsibilities and activities that the Departments of the Interior and Agriculture have under the program; we provide this information in appendix I.

## Results in Brief

From the program's inception through September 30, 1994, BOR, BLM, and USDA had spent a total of about $362 million on title II salinity control projects, and these agencies have plans to spend an additional $430 million.[1] BOR had spent about $266 million on six salinity control projects, primarily to line irrigation canals to eliminate water seepage. Three of these projects were completed, and three were under construction. BOR has four additional projects in various stages of planning. BOR estimates it will need another $201 million for the three unfinished and the four currently planned projects. BLM had spent about $7 million on its salinity control program, which encompasses designated salinity control projects as well as other land management activities intended to control salinity and provide other benefits, according to program managers. BLM's projects generally concentrate on reducing the erosion of soil that has a high salt content. For fiscal year 1995, BLM program managers expect to spend about $800,000 on salinity control. USDA had spent about $89 million on about 1,300 contracts for salinity control projects on farms in five project areas. Farmers voluntarily participate in these projects to reduce water seepage through the use of more efficient irrigation methods. USDA program managers forecast that they will spend about $228 million more to complete salinity control activities in the five current project areas.

Several factors are considered in selecting a salinity control method from the available alternatives. Key among these factors are the method's effectiveness and cost. For example, to prevent seepage from an earthen irrigation canal, agency officials might consider lining the canal with plastic or cement, or replacing it with a pipe. If all three were equally effective, agency officials explained, they would select the cheapest method. Feasibility and the effect on the environment are other factors considered when salinity control methods are selected.

Since 1974, according to Interior's salinity control measurements, the program has been successful in meeting its goal of maintaining salinity levels at or below the limits approved by the EPA under the Clean Water Act. Without additional, new salinity control projects, according to BOR data, salinity levels would exceed the established limits by about the year 2000 and would steadily increase thereafter. With completion of all planned projects, BOR expects salinity levels to remain within the established limits beyond the year 2010.

[1]Expenditures are actual outlays; we did not adjust them to reflect inflation because, in some cases, year-to-year data were not readily available.

## Background

The salinity of the Colorado River increases dramatically as the river makes its way along its 1,400-mile journey from its headwaters in Wyoming and Colorado to its termination in Mexico. Nearly half of the salinity is caused by nature, when, for example, groundwater flows through salt formations and enters the river or when saline springs contribute their salt to the river. But another major contributor to the river's salinity is the use of the water for agriculture. Simply put, when water is diverted from the river for irrigation, the salinity increases as the level of water in the river is depleted. Some of the diverted water, once applied to crops, then seeps into the ground, picks up salt from the soil, and returns—now with a much higher saline content—to the river. Because there is less water remaining in the river to dilute the salt, salinity increases.

Two major pieces of legislation address the salinity of the Colorado River. The first, the Clean Water Act, as amended (33 U.S.C. 1251, 1313), required national water quality standards. In response to the requirements of this act, the EPA approved numeric criteria for salinity levels at three monitoring stations along the Colorado River. The salinity of the water passing these stations is not supposed to exceed these criteria. As part of its treaty of February 3, 1944, and an agreement of August 30, 1973, with the Republic of Mexico, the United States agreed to take measures to ensure that the water flowing into Mexico from the Colorado River would have an average annual salinity concentration based on that of the Colorado River water arriving at the Imperial Dam.[2] The Imperial Dam, near Yuma, Arizona, is the last U.S. station at which salinity standards have been set before the river enters Mexico.

The second act, the Colorado River Basin Salinity Control Act of 1974, as amended (43 U.S.C. 1571, 1591), was passed to enhance and protect the quality of water delivered to users in the United States and Mexico. Title I of the act primarily authorized the Secretary of the Interior to construct a desalting plant to enable the United States to comply with its treaty obligation to Mexico. Title II of the act directed the Secretary to proceed with a salinity control program. Specifically, title II authorized the Secretary, through BOR, to proceed with the construction of four specific salinity control projects and to continue the planning of several other projects. The 1984 amendments to the act required two additional agencies—BLM and USDA—to implement salinity control programs. The

[2]Specifically, Minute No. 242 of the International Boundary and Water Commission, United States and Mexico, states that the salinity concentration of Colorado River water entering Mexico will not exceed, by more than 115 parts per million (plus or minus 30) of total dissolved solids, the average annual salinity concentration of the water at the Imperial Dam.

amendments also authorized BOR to construct two additional salinity control projects and deauthorized one of the previously authorized projects.

Federal agencies' efforts are coordinated through the Interagency Salinity Control Coordinating Committee and the Technical Policy Coordination Committee. At the state level, representatives from each of the seven Colorado River Basin states (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming) serve on the Colorado River Basin Salinity Control Forum and Advisory Council. The Forum coordinates states' actions and, along with the Advisory Council, advises the federal agencies on states' views on issues affecting salinity. The Forum developed basinwide salinity standards for states' adoption, including a plan of implementation. The Forum has also conducted triennial reviews of the standards, including updates to the plan of implementation.

Regardless of the method used, the objective of salinity control is the same: to decrease the salinity of the river by preventing salt from directly washing into it or percolating through the soil and entering it. Among the methods used are (1) lining irrigation delivery systems, such as canals and laterals (ditches that carry water to plots of land); (2) controlling sources of strong saline solutions, or brine, either by pumping the brine into wells below the water table or by plugging its source; (3) controlling the erosion of saline soils; and (4) improving or modernizing agricultural irrigation systems to reduce the amount of irrigation water used, and in turn reduce the amount of salt contributed to the river.

## Cost and Status of Salinity Control Projects

By the end of September 1994, BOR, BLM, and USDA had spent a total of about $362 million on title II salinity control projects. BOR had completed construction on 3 of its 10 salinity control projects; the remaining 7 were in various stages of planning or construction. BLM had controlled salinity through projects specifically devoted to this task as well as through multipurpose projects. USDA had conducted salinity control projects on farms in cooperation with individual farmers. (See app. I for more information on the program activities of the three agencies.)

### Bureau of Reclamation's Projects

Through September 30, 1994, the Congress had authorized BOR to spend up to $301 million on the construction of salinity control projects, of which $266 million had been expended. (The authorization total, or ceiling, has been increased each year to reflect inflation.) Within the authorization

ceiling, according to a BOR official, funds may be allocated among the various projects as needed.

By the end of September 1994, BOR had completed construction on three salinity control projects, at a combined cost of about $69 million. Construction was under way on another three projects, and the remaining four projects were in various stages of planning. (App. I describes the 10 projects.) According to BOR program managers, completing the unfinished and currently planned projects will cost about $200 million. Table 1 summarizes the status and construction cost of BOR's 10 projects; figure 1 shows the projects' locations in the Colorado River Basin.

**Table 1: BOR's Salinity Control Project Activities Through Fiscal Year 1994**

| Project | Status | Project activity | Expenditures through fiscal year 1994 (dollars in millions) | Total cost when completed (dollars in millions)[a] |
|---|---|---|---|---|
| Meeker Dome (Colorado) | Completed | Plugged three oil wells | $3 | $3 |
| Las Vegas, Pittman Bypass (Nevada) | Completed | Constructed a 4-mile pipeline | 2 | 2 |
| Paradox Valley (Colorado) | Completed[b] | Injected brine about 3 miles beneath the surface | 64 | 67 |
| Grand Valley (Colorado) | Under construction | Lining about 45 miles of canals; replacing 338 miles of laterals with pipe | 136 | 159 |
| McElmo Creek (Colorado) | Under construction | Lining about 34 miles of laterals; replacing 7 miles of laterals with pipe | 38 | 39 |
| Lower Gunnison Basin: Winter Water (Colorado) | Under construction | Replacing a winter watering system for livestock with 140 miles of pipe | 23 | 25 |
| Lower Gunnison Basin: East Side Laterals (Colorado) | In planning[c] | Combining laterals; replacing laterals with pipe | 0 | 53 |
| San Juan- Hammond (New Mexico) | In planning[d] | Lining 20 miles of canal and 7 miles of laterals | 0 | 12 |
| Uintah Basin (Utah) | In planning[d] | Lining over 55 miles of canals and laterals | 0 | 29 |
| Price-San Rafael (Utah) | In planning[d] | Installing 97 miles of pipe laterals | 0 | 78 |
| **Total** | | | **$266** | **$467** |

[a]The total cost does not include annual operations and maintenance costs.

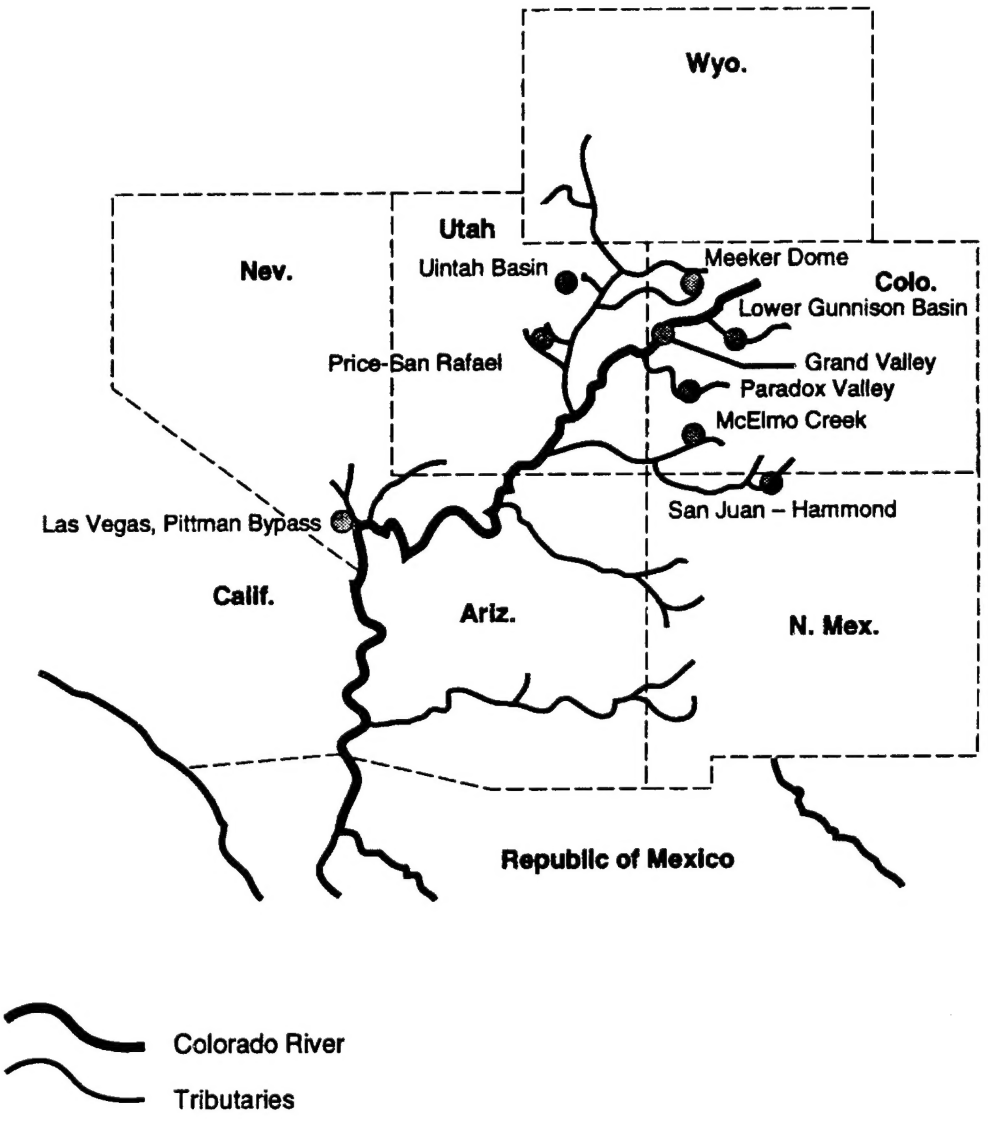
[b]This project was completed in 1994 and is being tested to operate in 1995.

[c]This project has been authorized but construction has not yet begun.

[d]These projects have not yet been authorized.

Source: BOR.

**Figure 1: Location of BOR's Salinity Control Projects**




Note: The Lower Gunnison Basin project includes two separate projects.

Source: BOR.

## Bureau of Land Management's Projects

From 1984 through September 30, 1994, BLM had spent about $7 million on its salinity control program. BLM generally incorporates salinity control objectives in its multipurpose resource land management plans, which describe management alternatives for all resources on and uses of the 270 million acres of public land that BLM manages. As part of its multipurpose land management, BLM has built structures in gullies designed to prevent soil from washing away during heavy thunderstorms and has improved ground cover that naturally holds the topsoil together and keeps it from washing away. Additionally, BLM has implemented specific salinity control projects, such as plugging abandoned oil and gas wells that were known sources of salt. According to BLM's salinity control program coordinator, information on the specific number of salinity control projects and their costs was not readily available. However, according to this manager, BLM has undertaken at least 14 such projects. Table 2 shows examples of BLM's salinity control activities in fiscal year 1994, as well as the expenditures, by state, for these specific activities. For fiscal year 1995, BLM expects to spend about $800,000 on salinity control.

**Table 2: Selected Salinity Control Activities by BLM in Fiscal Year 1994**

| State | Total expenditures for salinity control (dollars in thousands) | Examples of salinity control activities |
|---|---|---|
| Arizona | $49 | Inventoried soils to identify saline soils; identified water sources for salinity control; collected and monitored water measurement data |
| Colorado | 149 | Inventoried soils to identify saline soils; installed water monitoring stations; prescribed burning to increase vegetation cover |
| New Mexico | 72 | Initiated a quarterly water quality monitoring program; conducted salinity studies; established vegetation |
| Nevada | 30 | Conducted a study on the salinity of three streams; updated a soil survey to identify salinity |
| Utah | 180 | Revegetated 200 acres; reconstructed an earthen dike and dam; collected data on precipitation, associated runoff, sediment, and the salt contributed to the river |
| Wyoming | 150 | Plugged a flowing saline well; rehabilitated 8 miles of eroding roads; planted trees to stabilize eroding stream banks |

Source: BLM.

## Department of Agriculture's Projects

Through September 30, 1994, USDA had spent about $89 million on its salinity control program. The program, in which farmers voluntarily participate, emphasizes the use of efficient irrigation methods to reduce water seepage (which contributes salt to the river). Through this program, USDA primarily (1) identifies sources of salt and develops remediation plans; (2) provides financial and technical assistance to farmers to plan, undertake, and maintain projects that reduce seepage; and (3) monitors and evaluates the effectiveness of such practices. USDA funds 70 percent of the cost of salinity control projects; the landowners fund the remaining 30 percent.

Through September 30, 1994, USDA had about 1,300 contracts for salinity control projects on farms in five project areas located in Colorado, Utah, and Wyoming. These projects generally involve installing underground pipelines; lining earthen ditches, canals, and laterals; leveling land to reduce runoff; and replacing conventional irrigation systems with more efficient ones. These projects have affected a total of about 150,000 acres, or about 40 percent of the approximately 360,000 acres targeted for treatment. According to USDA program managers, it will cost about $228 million more to complete projects in the five current project areas. (See app. I for more information on USDA's program activities.) Table 3 shows—by project area, through fiscal year 1994—the expenditures, the number of active contracts, and the type and number of salinity control methods.

**Table 3: USDA's Salinity Control Project Activities Through Fiscal Year 1994**

| Project area | Expenditures through fiscal year 1994 (dollars in millions) | Total cost when completed (dollars in millions) | Active contracts (number) | Irrigation systems installed (number) | Pipeline installed (feet) | Ditches lined (feet) | Land leveled (acres) |
|---|---|---|---|---|---|---|---|
| Grand Valley (Colorado) | $26 | $63 | 392 | 1,617 | 2,220,031 | 371,712 | 4,964 |
| Uintah Basin (Utah) | 37 | 60 | 494 | 1,790 | 3,979,657 | 0 | 2,452 |
| Big Sandy (Wyoming) | 7 | 19 | 15 | 95 | 138,512 | 0 | 0 |
| Lower Gunnison (Colorado) | 14 | 145 | 224 | 402 | 789,293 | 108,130 | 1,262 |
| McElmo Creek (Colorado) | 5 | 30 | 170 | 218 | 402,991 | 0 | 0 |
| **Total** | **$89** | **$317** | **1,295** | **4,122** | **7,530,484** | **479,842** | **8,678** |

Note: Individual landowners or farms can have multiple contracts.

Source: USDA.

## Program Managers Consider Various Factors in Selecting Projects' Methods

In their search for viable ways to control the amount of salt being added to the Colorado River, program managers from BOR, BLM, and USDA have considered a variety of site-specific methods. These range from lining irrigation canals, to implementing more efficient irrigation systems, to retiring land from agricultural use. In selecting a particular salinity control method from among the available alternatives, agency officials said they consider several factors. These factors include the various methods' cost and effectiveness, as well as their feasibility and environmental effects.

According to agency officials, cost and effectiveness are key considerations in selecting from among the alternative methods. Table 4 illustrates the cost-effectiveness and other factors considered by BOR managers (in December 1993) in evaluating alternative methods for one project.

**Table 4: Some Alternative Methods Considered for BOR's San Juan-Hammond Project**

| Method considered | Projected amount of salt controlled (tons/year) | Estimated cost-effectiveness (dollars/ton) | Comments |
|---|---|---|---|
| Line canals | 27,700 | $41.65[a] | Recommended method; most cost-effective; lowest environmental impact; preferred by water users |
| Install low-pressure pipelines | 18,400 | 88.75 | None |
| Retire land | 31,560 | 187.00 | Not acceptable to State of New Mexico and most irrigators; could result in the elimination of up to 3,933 acres of irrigated land and the abandonment of 27 miles of canal and 10.3 miles of laterals |
| Install high-pressure pipelines | 18,400 | 235.00 | None |
| Install low-pressure pipelines for the Muñoz Canyon part of project | 31,700 | $98.00 | Water rights unavailable |

[a]BOR subsequently estimated the cost-effectiveness for this method at $34 per ton, as reflected in table 5.

Source: BOR.

BOR and USDA program managers use the same formula to compute a method's cost-effectiveness.[3] Essentially, the formula divides a method's estimated annualized cost by the tons of salt it is expected to control annually, yielding the cost of preventing 1 ton of salt from entering the river.[4] Annualized costs are composed of capital costs as well as

[3]BLM program managers do not compute cost-effectiveness, largely because of the multipurpose nature of their salinity control projects.

[4]We did not evaluate the formula as a measure of cost-effectiveness.

operations and maintenance (O&M) costs. The total capital cost is annualized by amortizing it using an 8-percent interest rate over the life of the project. For example, the capital cost of the Las Vegas, Pittman Bypass project was $1,757,000. Amortizing this cost over the expected life of the project (50 years) at 8 percent interest yields an annual cost of $143,371. Adding the annual O&M cost of $50,000 yields a total annual cost of $193,371. The project controls 3,800 tons of salt per year. Thus, the project's cost-effectiveness is $51 per ton: the annual cost ($193,371) divided by the amount of salt controlled (3,800 tons). Table 5 shows the cost-effectiveness of BOR's salinity control projects.

**Table 5: Cost-Effectiveness of BOR's Salinity Control Projects**

| Project[a] | Actual amount of salt controlled through fiscal year 1994 (tons/year) | Potential amount of salt controlled (tons/year) | Total cost (dollars in millions) | Annual O&M costs (dollars in millions) | Cost-effectiveness (dollars/ton) |
|---|---|---|---|---|---|
| Meeker Dome (Colorado) | 48,000 | 48,000 | $3 | [b] | $5 |
| Las Vegas, Pittman Bypass (Nevada) | 3,800 | 3,800 | 2 | $0.05 | 51 |
| Paradox Valley (Colorado) | 128,000 | 128,000 | 67 | 3.50 | 77 |
| Grand Valley (Colorado) | 99,900 | 131,300 | 159 | 0.43 | 102 |
| McElmo Creek (Colorado) | 23,000 | 23,000 | 39 | 0.03 | 138 |
| Lower Gunnison Basin: Winter Water (Colorado) | 38,734 | 41,380 | 25 | 0.41 | 58 |
| Lower Gunnison Basin: East Side Laterals (Colorado) | [c] | 64,000 | 53 | [d] | 68 |
| San Juan-Hammond (New Mexico) | [c] | 27,700 | 12 | [d] | 34 |
| Uintah Basin (Utah) | [c] | 25,500 | 29 | [d] | 93 |
| Price-San Rafael (Utah) | [c] | 161,000 | 78 | [d] | 39 |

[a]The expected life is 50 years for all but two projects: Meeker Dome's expected life is 100 years; Paradox Valley's is 25 years.

[b]No O&M costs are incurred for this project, which entailed plugging oil wells.

[c]These projects are still in various stages of planning.

[d]BOR does not expect to have O&M costs on these projects.

Source: BOR.

As shown in table 5, the cost-effectiveness of BOR's projects ranges from $5 per ton to $138 per ton. The variance in cost-effectiveness, according to the BOR Salinity Control Program Coordinator, stems from many things, such as the number and type of activities involved (as shown in table 1), the size and complexity of the project, and advances in technology (e.g.,

using a strong, thin plastic membrane rather than concrete to line canals or laterals). The BOR coordinator believes that as the Bureau has gained experience in salinity control over the years, it has gotten better at identifying and implementing more cost-effective methods for projects.

Although the cost-effectiveness of USDA's projects also varies, the variance is not as much as for BOR's projects. Overall, USDA's projects tend to cost less per ton of salt controlled than BOR projects, mostly because they are smaller, simpler projects. Table 6 shows the cost-effectiveness of USDA's salinity control projects.

**Table 6: Cost-Effectiveness of USDA's Salinity Control Projects**

| Project | Actual amount of salt controlled through fiscal year 1994 (tons/year) | Potential amount of salt controlled (tons/year) | Projected total cost (dollars in millions) | Cost-effectiveness (dollars/ton) |
|---|---|---|---|---|
| Grand Valley (Colorado) | 63,074 | 132,000 | $63 | $38 |
| Uintah Basin (Utah) | 77,549 | 106,800 | 60 | 45 |
| Big Sandy (Wyoming) | 22,313 | 52,900 | 19 | 29 |
| Lower Gunnison (Colorado) | 18,878 | 166,000 | 145 | 70 |
| McElmo Creek (Colorado) | 9,419 | 46,000 | 30 | 51 |

Note: Because O&M costs are borne by the participants in a project rather than by USDA, they are excluded from this table.

Source: USDA.

In addition to cost-effectiveness, program managers also consider factors such as the available methods' acceptability to users, legality, and potential effect on wildlife. Consideration of these factors, aside from or in addition to cost-effectiveness, can lead to a method's rejection, according to program managers. For example, retiring land from agricultural use has generally been considered an unacceptable method of controlling salinity, primarily because of its adverse effect on the local economy. Additionally, in terms of cost-effectiveness, retiring land generally fares poorly compared to other methods.

Another method is marketing the water for municipal and industrial uses rather than using it for irrigation within a particular state.[5] To date, however, water marketing has faced political and legal barriers. For example, several proposals to allow the marketing of conserved water have been defeated by the Colorado State Legislature. However, water marketing of conserved water is allowed in California, as we discussed in our May 1994 report.[6]

Methods have also been rejected because they were environmentally unsound. For example, for the Paradox Valley project, program managers considered piping brine into a holding pond and letting it evaporate. This method was rejected because it was deemed dangerous to wildlife in the area.

## Interior's Measurements of Salinity Show That Statutory Limits Are Not Being Exceeded

Measurements of salinity since the inception of the program show that salt levels at the three established monitoring stations have remained below the limits instituted under the Clean Water Act, thus satisfying the program's goal. According to program managers, the goal could not be met beyond the year 2000 without the various title II projects.

In 1974, EPA required that "appropriate points in the Colorado River System" be selected at which numeric criteria for salinity concentrations would be established, using the 1972 averages. In 1975, the states adopted and EPA approved basinwide salinity standards. Under these standards, the average annual salinity was to be maintained at or below the average level found during 1972.

In 1975, accordingly, the Colorado River Basin Salinity Control Forum selected three monitoring stations at which to apply the numeric criteria. Program managers said they selected monitoring stations in the lower river basin because the effects of salinity were greater there than in the upper basin. The selected stations are at three locations: (1) below Hoover Dam, at the southern border of Nevada; (2) below Parker Dam, at the western edge of central Arizona; and (3) above Imperial Dam, near Yuma, Arizona. EPA approved the Forum's selections as being consistent with the regulatory requirements. The numeric criteria, stated in milligrams per

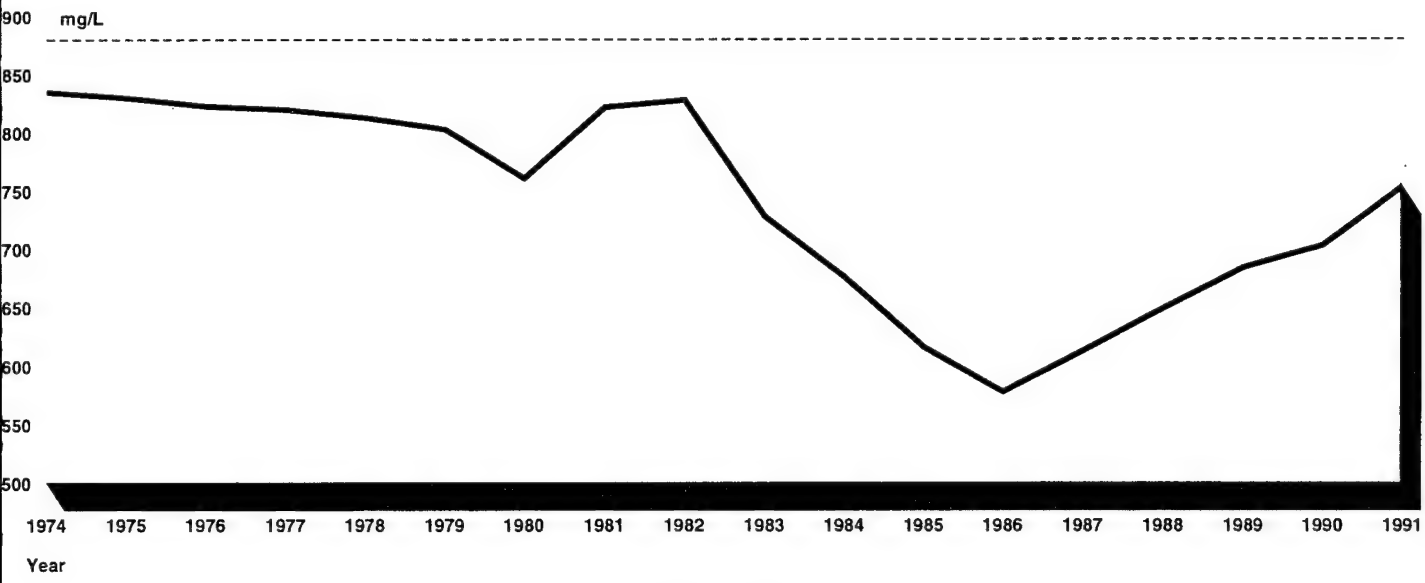
[5]Municipal and industrial uses generally contribute much less salt to the river than does agricultural use, according to BOR.

[6]Water Transfers: More Efficient Water Use Possible, If Problems Are Addressed (GAO/RCED-94-35, May 23, 1994).

liter (mg/L), are 723 mg/L for below Hoover Dam; 747 mg/L for below Parker Dam; and 879 mg/L for above Imperial Dam.

Since 1974, measurements of salinity at all three stations have been below the established limits. As an example, figure 2 shows the salinity measurements at the southernmost station (Imperial Dam), in relation to the limit (879 mg/L), from 1974 through 1991 (the latest year for which data were available).

**Figure 2: Salinity Measurements Above Imperial Dam, 1974 Through 1991**




Source: GAO's representation of data presented in Quality of Water, Colorado River Basin, U.S. Department of the Interior, Progress Rpt. No. 16 (Jan. 1993).

The dip in salinity shown in figure 2 is due primarily to the high-water years experienced through the mid-1980s, according to Interior's report cited above. The record-high flows during this period increased the volume of water in the river, thus lessening the concentration of salt. The

salinity levels for the same period at the other two monitoring stations, in relation to their established limits, followed a similar pattern.

According to Interior's January 1993 report, natural variations in the Colorado River, due to highly variable runoff and flows, cause salinity levels to vary significantly. The salinity control program is not intended to counteract the salinity fluctuations that result from the highly variable runoff and flows caused by climatic conditions, precipitation, snowmelt, and other natural factors. Rather, the program is designed to offset the effects of development, even as salinity varies from year to year in response to the climatic and hydrologic conditions. Salinity program reports concluded that, with the completion of the existing and planned control projects, salinity levels should remain at or below the criteria levels beyond the year 2010. Without these additional salinity control projects, according to BOR's projections, the salinity levels at Imperial Dam would exceed the established limits by about the year 2000, with steadily increasing levels thereafter.

## Agency Comments and Our Evaluation

As requested, we did not obtain written comments from the agencies included in our review. We did, however, discuss the data included in this report with officials from BOR, BLM, USDA, EPA, and the Colorado River Basin Salinity Control Forum:

- Officials from BOR's Upper Colorado Region (in Salt Lake City): the Regional Director; the Manager of the Resources Management Division; and the Program Manager, Colorado River Salinity Control Program.
- Officials from BLM's Denver Service Center: the BLM Senior Management Representative for the Colorado River Salinity Program and the BLM Technical Coordinator for the Colorado River Salinity Control Program.
- Officials from USDA's headquarters (in Washington, D.C.): the Director, USDA Natural Resources Conservation Service (formerly the Soil Conservation Service); the USDA Salinity Program Coordinator, Natural Resources Conservation Service; the Director of Conservation and Environmental Protection Division, USDA Consolidated Farm Service Agency (formerly the Agricultural Stabilization and Conservation Service); and the USDA Salinity Control Program Manager.
- Officials from EPA's Region VIII (in Denver): the Chief, Water Quality Branch, and the EPA Region VIII Salinity Coordinator.
- The Executive Director of the Colorado River Basin Salinity Control Forum (in Bountiful, Utah).

They generally agreed with the information presented in this report but suggested several technical and editorial changes that we incorporated where appropriate.

In conducting our review, we examined relevant documents prepared by the various participating agencies in the Departments of the Interior and Agriculture and by the Colorado River Basin Salinity Control Forum. We also interviewed program managers from these organizations at all organizational levels—in their Washington, D.C., regional, state, and local offices, as appropriate. In addition, we reviewed reports by the Office of the Inspector General of the Departments of the Interior and Agriculture. A full description of our scope and methodology is included in appendix II. We conducted our review from January 1994 through January 1995 in accordance with generally accepted government auditing standards.

As requested, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to appropriate congressional committees; federal agencies; the Director, Office of Management and Budget; and other interested parties. We will also make copies available to others on request. Please contact me at (202) 512-7756 if you or your staff have any questions about this report. Major contributors to this report are listed in appendix III.

James Duffus III
Director, Natural Resources
Management Issues

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**Abbreviations**

| | |
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| BLM | Bureau of Land Management |
| BOR | Bureau of Reclamation |
| EPA | Environmental Protection Agency |
| GAO | General Accounting Office |
| mg/L | milligrams per liter |
| O&M | operation and maintenance |
| USDA | U.S. Department of Agriculture |

# The Federal Salinity Control Program

At the federal level, the salinity control program includes various agencies within the Departments of the Interior and Agriculture (USDA) and the Environmental Protection Agency (EPA). Interior agencies involved in salinity control include the Bureau of Reclamation (BOR), the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service, and the U.S. Geological Survey. Coordination among the federal agencies is accomplished through the Interagency Salinity Control Coordinating Committee.

## Bureau of Reclamation

As the lead agency for the Department of the Interior's Salinity Control Program, BOR is responsible for coordinating efforts within Interior, investigating problems with salinity, analyzing the program's needs and accomplishments, and implementing specific congressionally approved salinity control projects. BOR primarily attempts to reduce the salt contributed to the Colorado River by reconstructing primary irrigation systems. Such reconstruction generally involves lining irrigation canals and laterals with concrete or plastic to eliminate the seepage and deep percolation of irrigation water into the groundwater. Other projects by BOR reduce the salt contributed to the river by blocking or controlling specific "point" sources. For example, in one project brine is injected into a deep well to prevent its entering the river.

By the end of September 1994, BOR had completed construction on three salinity control projects, at a combined cost of about $69 million. Construction was under way on another three projects, and another four projects were in various planning stages.

The Meeker Dome project, completed in 1983 at a cost of about $3 million, entailed plugging three wells that had originally been drilled for oil exploration but had been abandoned. The wells had been identified as significant contributors of salt to the Colorado River. The Las Vegas, Pittman Bypass project, completed in 1985 at a cost of about $2 million, entailed constructing a 4-mile pipeline to replace an unlined ditch that carried industrial wastewater. The unlined ditch had allowed seepage, which in turn increased the flow of salt into the groundwater and ultimately into the river. The Paradox Valley project, which was completed in 1994 at a cost of about $64 million (and which requires an estimated $3 million to test before it becomes fully operational), entailed injecting highly saline groundwater into a well about 3 miles beneath the surface, a depth that prevents the water from entering the river. The highly saline groundwater resulted from natural saline springs.

The Grand Valley project, scheduled for completion in 1998 at an estimated cost of $159 million, entails reducing seepage by lining about 45 miles of existing earthen irrigation canals and by replacing with pipe about 338 miles of existing earthen laterals, or ditches, which convey water from the canals to plots of land. The McElmo Creek project,[7] scheduled for completion in 1997 at a cost of about $39 million, entails lining 34 miles of existing irrigation canals, installing 7 miles of laterals, and combining existing canals into a new lined canal. The Lower Gunnison Basin project, scheduled for completion at a cost of about $78 million, includes two separate projects that entail reducing seepage by replacing an unlined canal with a pipe to make water available for livestock during the winter and by combining some laterals and replacing others with pipe.

The San Juan-Hammond project, with an estimated construction cost of about $12 million, is planned to entail lining about 20 miles of canal and 7 miles of laterals. The Uintah Basin project, estimated to cost about $29 million, is planned to involve lining over 55 miles of canals and laterals. The Price-San Rafael project, estimated to cost about $78 million, is planned to entail installing 97 miles of pipe for irrigation water.

## Bureau of Land Management

BLM administers 48 million acres in the Colorado River Basin above Imperial Dam, or about 36 percent of the basin's total area. Of this land, about 8 million acres contain saline soils. Most of the salt contributed to the river from BLM-managed lands is from "nonpoint" sources such as surface runoff, erosion, and the flow of groundwater. Point sources on BLM lands include saline springs, mining spoil piles, and some oil and gas production sites. According to program officials, the precise amount of salt contributed from BLM-managed lands is extremely difficult to determine because of variances in the movement of salt, sediment, and groundwater and because of the proximity of lands not under BLM's control.

BLM's primary focus for reducing the salt contributed to the river from lands it administers is to control erosion and to stop specific point sources (e.g., by plugging abandoned oil and gas wells that are such sources). BLM's efforts to control erosion include building "check-dams" to prevent soils from washing away during heavy rains and improving vegetation to better hold the ground in place. BLM also improves ground cover by controlling or limiting grazing.

[7]The McElmo Creek project is part of BOR's Dolores project, a water project located in southwestern Colorado.

From its earliest days, according to program managers, BLM has recognized the need for soil and water conservation on the lands it administers and has actively worked to control erosion. As early as the 1960s, BLM had increased its efforts to include water in its resource planning activities and to improve water quality. In 1974, the year the Colorado River Saliniy Control Act was enacted, BLM was already engaged in a special appraisal of the salt contributed to the river from BLM-administered lands. After the 1984 amendments, which formally added BLM to the salinity control program, BLM developed a comprehensive program for minimizing the salt contributed to the river. That program was described in an Interior report to the Congress in July 1987.[8]

BLM field offices have the primary responsibility for developing and implementing the resource management plans. Generally, each area manager prepares a plan for the geographic area he or she manages. However, district managers can initiate broader, overlapping plans when significant issues or conflicts arise. In developing these plans, BLM invites public review and participation. Thus, BLM receives from the public, as well as from federal, state, and local agencies, information on controlling salinity.

By the end of September 1994, BLM had spent about $7 million on the control of salinity—both through multipurpose resource management activities and specific salinity control projects. In fiscal year 1994, BLM spent about $800,000 on salinity control; the projected expenditure for fiscal year 1995 is $800,000.

## Department of Agriculture

USDA's salinity control program involves voluntary "cost-share" projects on farms and on lands adjacent to farms. Applicants agree to construct, operate, and maintain an irrigation improvement project designed to reduce the amount of salt contributed to the river as a result of irrigation practices. Primarily, these projects improve irrigation methods and delivery systems, thereby reducing the seepage and deep percolation of salt into the groundwater. The projects include improving sprinkler systems, installing pipe, and lining delivery canals. Landowners who wish to participate in the program submit an application to the local USDA office; each office assigns a priority to each application received. For example, in the Grand Valley project area, priorities are based primarily on need—that is, projects are ranked according to the level of salinity in the area. Thus, a

[8]Salinity Control on BLM Administered Public Lands in the Colorado River Basin, A Report to Congress, July 1987, U.S. Department of the Interior (Washington, D.C.: July 1987).

farm located in a highly saline area would receive a higher priority than would a farm in an area with less saline soil. Once an application is approved, the office develops a salinity control plan and executes an implementation contract with the applicant for a period of 3 to 10 years. Besides agreeing to build and install the project, the landowner agrees to operate and maintain the project for as long as 25 years.

By the end of September 1994, USDA had about 1,300 contracts for projects affecting about 150,000 acres. The program's expenditures through September 1994 were about $89 million; about $228 million more is needed to complete projects planned in the five project areas.

At the local level, USDA agencies administer the program through county offices. These offices identify potential acreage for treatment under the program; prepare estimates of project areas' funding needs; develop and present information about the program; review, prioritize, and approve applications for participation in the program; help applicants prepare salinity control plans; prepare construction contracts for the projects; prepare operation and maintenance agreements for the contracts; obligate and disburse cost-share funds; provide technical assistance to participants in the program; inspect and certify projects' completion; estimate and report on the reduction in salinity attributable to the projects; and maintain records and statistical reports.

## Other Agencies

EPA and Interior's Fish and Wildlife Service and U.S. Geological Survey are other agencies involved in the salinity control program. EPA reviews and approves water quality standards, including numeric criteria. EPA also reviews environmental documents and provides technical comments on the impacts that salinity control projects have on the environment and the plans to mitigate these impacts. The Fish and Wildlife Service provides support during planning for technical issues such as the impacts projects will have on fish, wetlands, and wildlife habitat. The Geological Survey monitors the salinity of the Colorado River, provides pertinent information in published reports, and conducts special investigations to identify sources of salt.

# Objectives, Scope, and Methodology

The Ranking Minority Member, House Committee on Resources, and the Ranking Minority Member, Subcommittee on Agriculture, Rural Development, Food and Drug Administration, House Committee on Appropriations, in their former roles as Chairs, asked us to review the Colorado River Basin Salinity Control Program. Specifically, they requested that we gather information on (1) the cost and status of the salinity control projects, (2) factors considered in selecting salinity control methods, and (3) the Department of the Interior's measures of the salinity control program's effectiveness. They also requested information on the responsibilities and activities of the agencies involved. We concentrated our review on three agencies involved in the salinity control program: Interior's BOR and BLM, and USDA.

We reviewed relevant documents and interviewed salinity control program managers in the Department of the Interior and USDA. In Interior, we met with program officials from BOR and BLM. In USDA, we met with program officials from the Agricultural Stabilization and Conservation Service and the Soil Conservation Service. We also interviewed the Colorado River Basin Salinity Control Forum's Chairman and Executive Director. Additionally, we interviewed representatives of the International Boundary and Water Commission, in El Paso, Texas; the Environmental Defense Fund, in Boulder, Colorado; and an irrigation district in Grand Junction, Colorado. Finally, we interviewed interested or concerned citizens in the Grand Junction area.

To determine the cost and status of salinity control projects, we obtained project summaries from program managers in Interior and USDA. To identify the factors considered in selecting project methods, we reviewed the project summaries and interviewed program managers in the two departments. To provide information on the salinity control program's effectiveness, we reviewed the Department of the Interior's salinity measurements and progress reports. We also interviewed officials from USDA's Office of the Inspector General and EPA's regional office in Denver.

Additionally, we reviewed four audit reports issued by the Inspectors General of the Departments of the Interior and Agriculture to identify recommendations pertaining to title II of the Salinity Control Act. We then reviewed the agencies' tracking files and interviewed agency officials about actions taken to implement the recommendations. At the time of our review, USDA's Inspector General was auditing the agency's salinity control projects in southwestern Colorado. The Inspector General's report had not been issued at the time of this report.

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